

Optimisation of a continuous fibre reinforced additive manufacturing process

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Extrusion based additive manufacturing (AM) techniques for thermoplastic materials have been developed during the last thirty years. In order to avoid limitations in mechanical properties such as strength, stiffness and toughness of additively manufactured products compared to their injection moulded counterparts, short fibre filled AM materials have been introduced more recently. To expand the possibilities of the extrusion based AM materials even further, a process which incorporates continuous fibres into the polymers was developed: Continuous Fibre Additive Manufacturing (CFAM). This process combines a thermoplastic polymer matrix and a continuous fibre bundle into a well-impregnated composite material right before its deposition, forming a 3D object. This process enables the manufacturing of complexly shaped parts that cannot be produced using traditional subtractive production technologies and gives the possibility to fully tailor and control fibre orientation, which is not always possible using the classic composite lay-up processes. These two advantages could lead to lighter, stronger and stiffer parts for use in high-end applications.

In this research, the effect of different parameters such as road width, layer thickness, fibre volume fraction and processing temperatures on the mechanical properties of the CFAM produced parts were investigated. This was done through 0° and 90° tensile tests to characterise intralayer properties, 0° short beam flexural tests to assess interlayer properties, thermogravimetric analyses to quantify fibre volume fraction and a morphology study to determine fibre dispersion and distribution in the matrix material. These material characteristics are of utmost importance to be able to fully compare the CFAM technique with currently existing processes and to assess its added value.